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Near-term incentives for electrifying ride-hailing vehicles in India

Author: Shikha Rokadiya, Sandra Wappelhorst, Nikita Pavlenko, Anup Bandivadekar

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Introduction

India's shared vehicle market has undergone significant structural changes in recent years. The advent of innovative, app-based ride-hailing services like Ola and Uber—referred to as cab aggregators—has expanded on-demand transport options for consumers beyond the traditional taxi industry (Organisation for Economic Co-operation and Development, 2018).

A parallel trend is the increased support for policies seeking to stimulate electric vehicle sales in India. Still, in 2018, the electric car stock of four-wheeled battery electric vehicles (BEVs) and plug-in hybrid electric vehicles (PHEVs) in India was only about 10,300 vehicles, of which 3,300 were sold in 2018. The market share of these was just 0.1%, again if counting only four-wheelers and excluding rickshaws and two- and three-wheelers (International Energy Agency, 2019).

Integrating electric cars in commercial services, which is to say in ride-hailing operations, is a promising way to both stimulate their uptake and dramatically increase the public's awareness of and exposure to the technology. Moreover, electric ride-hailing can be a sustainable and flexible complement to a regional transportation system, particularly for local travel (Pavlenko, Slowik, & Lutsey, 2019). Compared to an electric car in strictly private ownership, vehicles used for ride-hailing have, on average, higher annual mileage. Because of the opportunity this creates for greater annual fuel savings, it has the potential to accelerate the payback time. Additionally, leading markets globally have already implemented or are proposing mandates for the electrification of ride-hailing fleets in a phased manner over the next decade (Rokadiya, Bandivadekar, & Yang, 2019). India's largest cab aggregator, Ola, is also pursuing electrification. In 2018, the company announced its "Mission Electric" to accelerate the adoption of electric vehicles; its goal is to add 1 million electric vehicles to its platform by 2021, a share of about 20% (Ola, n.d.).

This paper builds on previous ICCT studies about electrifying ride-hailing fleets in U.S. and EU markets (Pavlenko et al., 2019; Slowik, Wappelhorst, & Lutsey, 2019) by expanding the view to conditions in the Indian market. Specifically, this paper focuses on the states of Delhi and Telangana and on four-wheelers, which accounted for 17% of new vehicle sales of passenger cars and commercial vehicles in India in fiscal year 2017–18 (Society of Indian Automobile Manufacturers, n.d.). We analyze the impacts of current financial incentives for cars purchased by a private person that are used for commercial services, which is to say in ride-hailing operations. This is our baseline scenario. In addition, we assess the impact of proposed and hypothetical policies that would enhance the cost-competitiveness of electric ride-hailing vehicles; the aim is to illuminate how the Central Government of India and state governments, along with other stakeholders including cab aggregators, power utilities, and charging providers, might induce purchase decisions toward electric vehicles in ride-hailing fleets. The question to be answered by the study is: What kinds of incentives and actions supporting electric vehicles are needed in the near term to make them a viable purchase for drivers in Indian ride-hailing fleets?

Methodology

To evaluate the cost impact of financial incentives for ride-hailing operations, we analyze the total cost of ownership (TCO) for different vehicle models in two Indian states, Delhi and Telangana. These two states represent large ride-hailing markets in India; they also have actively pursued policies to support the electrification of transport fleets. Further, these states differ with respect to energy pricing for both electricity and conventional fuels, and this allows us to model costs under two different energy-pricing scenarios.

This analysis compares the TCO of a representative BEV with an electric range of 140 kilometers (km) with popular gasoline, diesel, and compressed natural gas

(CNG)-powered conventional vehicles on ride-hailing platforms in India. Compared to BEVs, PHEVs have relatively high fueling and maintenance costs, and often operate similar to non-plug-in hybrid models in high-utilization fleets. Further, fuel cell electric vehicles (FCEVs) are in a nascent state of development and face greater barriers for deployment. Thus, PHEVs and FCEVs are excluded from our analysis. All references to *electric vehicles* (EVs) and *zero-emission vehicles* (ZEVs) in this paper are references to BEVs.

We first analyze the cost impact of financial incentives under current policies in the baseline scenario. Following that, we analyze a scenario that includes some proposed and hypothetical policies in the new policy scenario.

Financial incentives under current policy (baseline scenario)

KEY ASSUMPTIONS

For our scenario under current policy (baseline scenario), we estimate the TCO for a 5-year period, assuming vehicle procurement in 2020 and ownership through 2024. Table 1 outlines the selected vehicle models and their key specifications in terms of weight, length, displacement, battery capacity, and fuel consumption, all obtained from manufacturer websites. The fuel consumption figures for conventional vehicles are test values certified by the Automotive Research Association of India. For the reference BEV, test-consumption values are not disclosed by the manufacturer. Instead, we estimate the consumption based on efficiency projections for battery technologies in 2020, as identified in previous studies (e.g., Slowik & Lutsey, 2016).[1]

To compare costs for the different models, we analyze vehicle purchase costs, costs associated with financing, taxes and fees, maintenance costs, insurance costs, fuel costs, and the opportunity costs of fueling, as well as incentives for BEVs available from the Central Government of India.[2] We also make some standard assumptions. For example, we assume that vehicles in ride-hailing fleets are purchased and owned by the drivers and are subject to an amortization period of 5 years. We base our calculations on the year 2020 and apply a discount rate of 5% to obtain the present value of 5-year costs, in line with previous studies (Pavlenko et al., 2019).

We also make several assumptions about *vehicle utilization* based on random sampling surveys of cab drivers in Delhi and Hyderabad conducted by the ICCT in 2019. Based on the survey results, we assume all vehicles will be logged into ride-hailing platforms for an average of 12 hours a day and travel an average of 200 km per day for 317 days a year. We further assume that 67% of the total time logged in daily is spent on trips that earn revenue. We assume that all drivers have access to overnight residential slow charging. Using a weighted random distribution of distance traveled per day over the annual operation of the BEV, we assess the number of days per year that drivers will travel beyond the BEV's range and assume that this remaining distance is powered via fast charging. Further, we assume that BEV drivers will opt to fast charge the vehicle as soon as the vehicle range drops to about 25% state-of-charge, or about 35 km remaining on the battery. Based on these assumptions, our estimates indicate that BEV drivers will meet their daily charging needs through one overnight charge and an average of 1.35 fast-charging cycles on public chargers per day.

Table 1. Selected models for analysis

Fuel type	Manufacturer	Model	Curb weight (kg)	Length (mm)	Displacement (cc)	Battery capacity (kWh)	Fuel consumption (per 100 km)
BEV	Mahindra	eVerito D2	1,265	4,247	NA	18.55	17.05 kWh
CNG	Maruti Suzuki	WagonR LXI CNG	805	3,655	998	—	2.98 kg
Gasoline	Maruti Suzuki	Suzuki Dzire LXI	860	3,995	1,197	—	4.55 l
Diesel	Maruti Suzuki	Suzuki Dzire LDI	955	3,995	1,248	—	3.52 l

1 The study by Slowik and Lutsey averages a representative sample of electric vehicles from U.S. Environmental Protection Agency fuel economy data, available at https://www.fueleconomy.gov/feg/download.shtml, to get an average efficiency of 0.3 kWh/mi in 2016. It then assumes a 2% annual efficiency improvement, which yields around 0.27 kWh/mi in 2020 and goes to 0.25 kWh/mi in 2025.

2 We assume that a battery replacement will not be needed over the 5-year use period and do not account for this cost in our TCO estimates.

Charging time is a function of the vehicle's battery capacity and the speed of the charger. Our assumptions of fast-charge cycle times are based on manufacturer claims at 25°C at a rate of transfer of 10 kW (Mahindra, 2019). Pilot trials conducted by the Ola Mobility Institute (2019) indicate that fast charging is strongly influenced by temperature and it can take up to twice as long to reach full charge in extreme summer heat. The Ola study also indicated that the amount of electricity needed to reach full charge through fast charging can increase by as much as 50% during summer months. We account for such seasonal variations in our analysis by assuming that both fast-charging cycle time and electricity consumed to reach full charge increase by an average factor of 1.5 during three months in a year. Table 2 summarizes the assumptions regarding charging behavior.

Table 2. Assumptions about charging behavior

Charging parameter	Assumption
Full fast-charge cycle time – summer	135 minutes
Full fast-charge cycle time – rest of year	90 minutes
Full fast-charge cycle time – weighted average	101 minutes
Fast-charge events per day	1.35
Overnight slow-charge events per day	1

These assumptions about charging times for India are significantly longer than those for the United States and Europe. For example, our assumption for the United States is that, in 2018, it took a little more than half an hour to add 70 miles of range (113 km) at a transfer rate of 37 kW (Pavlenko et al., 2019). This transfer rate is anticipated to increase to as high as 150 kW–350 kW by 2025 as a result of next-generation, high-powered charging stations. In comparison, India's fast charging standard, Bharat DC-001, is for supply at 15 kW. Mahindra is also selling fast chargers rated at 10 kW.

In terms of *vehicle procurement costs*, we assume that all vehicles will be financed through a 5-year loan with a 15% down payment. For conventional cars, we assume an annual interest rate of 12%. For BEVs, we assume a discounted interest rate of 11.8% with no processing fee, in line with recent announcements by the State Bank of India for loans for electric vehicles (The Hindu BusinessLine, 2019). Further, our vehicle price assumptions for 2020, as outlined in Table 3, also account for the increase in prices of conventional vehicles, notably diesel-powered vehicles, based on ICCT estimates of incremental technology costs after the implementation of Bharat Stage VI emission standards in April 2020.

Table 3. Vehicle price assumptions in 2020

Fuel type	Manufacturer	Model	Ex-showroom price (INR lakhs)
BEV	Mahindra	eVerito D2	12.4
CNG	Maruti Suzuki	WagonR LXI CNG	4.9
Gasoline	Maruti Suzuki	Suzuki Dzire LXI	5.7
Diesel	Maruti Suzuki	Suzuki Dzire LDI	7.3

The *upfront taxes* levied by the Central Government of India include the goods and service tax (GST), which is allocated equally toward state and central GST. In addition, there is the compensation cess and tax collected at source (TCS) for vehicles costing more than INR 100,000. These taxes are levied on the base price of the vehicle. BEVs are preferentially taxed under GST and are exempt from the compensation cess altogether. In the 2019 Union budget, India's finance minister announced that the rate of GST levied on BEVs would be further lowered from 12% to 5%, and this was approved by the GST Council. However, BEVs are not eligible for preferential rates or exemptions from the TCS. The Central Government also sets vehicle registration fees for all classes of vehicles. The Ministry of Road, Transport and Highways (MoRTH) has proposed a 10-fold hike in registration fees of commercial taxis from INR 1,000 to INR 10,000. Further, the MoRTH has proposed that electric vehicles of all classes be exempt from registration fees altogether. As the proposals are expected to be adopted, we account for these changes in registration charges in our baseline TCO. The rate of upfront taxes and registration fees assumed in our analysis is summarized in Table 4.

Table 4. Assumed upfront taxes on electric and conventional passenger cars

GST	Cars ≤ 4m length	Cars > 4m length
Electric vehicles	5%	5%
Gasoline, diesel, CNG	28%	28%
Central compensation cess		
Electric vehicles	0%	0%
Gasoline	1%	15%
Diesel	3%	15%
CNG	1%	15%
CENTRAL TCS (APPLIES IF BASE PRICE > INR 1,000,000)		
All fuel types	1%	
REGISTRATION CHARGES – COMMERCIAL LIGHT-DUTY VEHICLES		
Electric vehicles	—	
Gasoline	INR 10,000	
Diesel	INR 10,000	
CNG	INR 10,000	

In addition to the above taxes and fees, passenger cars used as commercial vehicles are also subject to *recurring taxes and fees* levied by states. In Delhi, these are an annual road tax, annual parking fee, and permit fee payable once every 5 years. In Telangana, the recurring costs include a quarterly road tax and a permit fee payable once every 5 years. Table 5 and Table 6 summarize the recurrent taxes and fees applicable in Delhi and Telangana, respectively, for commercial passenger vehicles. We model all the taxes and fees applicable.

Table 5. Taxes and fees for commercial passenger vehicles in Delhi

Frequency	Delhi taxes and fees	Rate
Annual	Road tax	605 INR
Annual	Parking charges	2,500 to 4,000 INR
Every 5 years	Permit fee	500 INR

Table 6. Taxes and fees for commercial passenger vehicles in Telangana

Frequency	Telangana taxes and fees	Rate
Quarterly	Road tax	652.05 INR
Every 5 years	Permit fee	500 INR

Regarding *insurance premiums*, we assume that all vehicles are covered by a third-party damage policy, as is mandatory under Indian regulations, an own-damage policy, and a mandatory personal-accident policy for every driver. The insurance premiums for third-party damage coverage are regulated by the Insurance Regulatory and Development Authority (IRDAI) of India. We assume the premiums specified under the latest IRDAI order at the time of this study, which is to say the IRDAI motor tariff for financial year 2019–2020, as the tariffs prevailing in 2020 (IRDAI, 2019). The 2019–2020 tariff order specifies a discounted rate for private electric cars in comparison to private conventional cars. However, a discounted rate for commercial electric cars is not specified in comparison to commercial conventional cars. In the absence of a tariff for commercial four-wheeled BEVs, we assume the tariff applicable for commercial conventional vehicles exceeding 1,000 cc but not 1,500 cc applies to the BEV modeled in our study. Table 7 summarizes the third-party premiums assumed.

Although the rates for third-party damage coverage are regulated by the IRDAI, the insurance premiums for own-damage coverage are set by insurance providers with competitive profit margins. We obtained price quotes for the representative models considered in our study and found that the premiums varied by fuel type. Our estimates for own-damage premiums for conventionally powered taxis are based on quotes from the online tool of Coverfox Insurance Broking Pvt. Ltd. (Coverfox, 2019), which are assumed to prevail in 2020. For the BEV, our estimates are based on insurance premiums indicated by the online tool of CarAndBike (CarAndBike, 2019), which are significantly higher due to the high upfront pricing of the BEV. Our assumptions regarding own-damage insurance premiums are summarized in Table 8.

Table 8. Assumptions for own-damage insurance premiums in 2020

Reference vehicle	Annual own-damage insurance premium
BEV	23,000 INR
Gasoline	14,580 INR
Diesel	17,669 INR
CNG	11,388 INR

For *residential electricity rates*, we assume the latest tariff orders declared at the time of this study for full year 2018–2019 for both Delhi and Telangana (Delhi Electricity Regulatory Commission, 2018; Telangana State Electricity Regulatory Commission, 2019). We consider tariffs to prevail in 2020, building on residential electricity rates based on incremental block tariff structures and assuming rates corresponding to the 400 kWh to 800 kWh consumption bracket. For public fast charging, we assume the latest preferential tariffs specified by Delhi, for financial year 2017–2018, and by Telangana, for financial year 2018–2019, for supply to charging stations to prevail in 2020 (Telangana State Electricity Regulatory Commission, 2018). We further add INR 3 per kWh to the preferential tariffs as an estimate of the rate paid by vehicle drivers (India Smart

Table 7. Assumptions for third-party insurance premiums in 2020

IRDAI rate category: 4-wheeled vehicles used for carrying passengers for hire or reward with carrying capacity not exceeding 6 passengers	Annual premium	Additional premium per licensed seating capacity	Total annual premium for a 5-seater vehicle
Conventional vehicles ≤ 1,000 cc	5,769 INR	1,110 INR	11,319 INR
Conventional vehicles > 1,000 cc ≤ 1500 cc	7,584 INR	934 INR	12,254 INR
Conventional vehicles > 1,500 cc	10,051 INR	1,067 INR	15,386 INR
BEVs (no tariff from IRDAI specified for commercial vehicles; assumed rate applicable to conventional vehicles > 1,000 cc ≤ 1,500 cc)	7,584 INR	934 INR	12,254 INR

Grid Forum, 2018). Whereas Delhi specifies a flat tariff, Telangana offers a time-of-use (TOU) tariff structure for fast charging. We estimate an average tariff by assuming that 50% of fast charging will take place between 10 a.m. and 6 p.m., and the remaining 50% equally between 6 a.m. and 10 a.m. and 6 p.m. and 10 p.m. For conventional fuels, we estimate prices in 2020 based on a compound annual growth rate analysis of gasoline, diesel, and CNG prices between 2015 and 2019. Table 9 summarizes the average electricity rates and fuel prices considered.

Table 9. Assumptions of average electricity rates and fuel prices in 2020

		Delhi	Telangana
Electricity	Residential overnight-charging	6.5 INR/kWh	9.0 INR/kWh
	Public fast-charging	8.0 INR/kWh	9.5 INR/kWh
Fuel	Gasoline	73 INR/liter	79 INR/liter
	Diesel	70 INR/liter	75 INR/liter
	CNG	48 INR/liter	67 INR/liter

The *maintenance costs* for BEVs are generally less than they are for conventional vehicles, primarily because (1) electric motors have far fewer parts than internal combustion engines; (2) electric motors do not require engine fluids; and (3) there is less wear and tear on bakes due to regenerative braking in electric vehicles. We assume maintenance costs of about INR 0.1 per km for BEVs, INR 0.4 per km for CNG vehicles, INR 0.6 per km for gasoline vehicles, and INR 0.8 per km for diesel vehicles (CarDekho, 2019a, 2019b, 2019c; Povaiah, 2017).

The *opportunity cost* is the lost revenue potential due to time spent on recharging or refueling. We base our estimate of the number of refueling events per day for conventional vehicles on the certified mileage values and fuel-tank capacities of the models considered. We further assume that it takes 5 minutes to refuel gasoline and diesel tanks to full capacity and 30 minutes to refuel CNG tanks to full capacity. Recharging times for the BEV are as presented in Table 2. We assume the BEV, gasoline, and diesel models considered in our study are sedans earning a higher fare of INR 12 per km, and the CNG models are a compact car earning INR 10 per km. The classifications of *sedan* and *compact* in our study are based on how cab aggregators in India categorize the models and do not reflect any official classification by the auto industry in India. Based on these assumptions and the daily utilization assumptions summarized earlier, we estimate an opportunity cost of INR 112 per hour for sedans and INR 89 per hour for compact cars.

The Central Government of India offers an upfront purchase incentive for commercial battery operated four-wheelers of INR 10,000 per kWh of battery capacity. Further, the Central Government also taxes BEVs preferentially under the GST regime, as previously presented in Table 4. Both of these incentives are considered in our TCO analysis for the representative BEV. Both Delhi and Telangana have proposed incentive mechanisms that apply to this segment in their draft state-level electric vehicle promotion policies. Delhi's proposed incentives include waiving registration fees, permit fees, annual road taxes, and annual parking charges. Telangana's proposed incentives include waiving the quarterly road tax. However, neither state has yet finalized their policies; hence, such incentive mechanisms are excluded from our baseline scenario, which models incentive mechanisms that are already in effect.

RESULTS

The assumptions regarding costs and incentives discussed above are applied to the chosen vehicles over a 5-year use period to create a baseline scenario. We first quantify the TCO for the selected BEV and conventional vehicles in such a baseline scenario. The results, normalized to the distance traveled over 5 years, are presented in Figure 1. The colors in the chart represent the various costs and the hashes indicate the cost reduction as a result of the incentives available from the FAME-II subsidy.

The 5-year TCO for the CNG model is the lowest and the TCO for the BEV is the highest among all the vehicles compared in both Delhi and Telangana. The conditions in Delhi and Telangana mainly differ with respect to energy costs for electricity and conventional fuels—both are higher in Telangana. In Delhi, the 5-year cost difference between the BEV and CNG models is about INR 11.8 lakhs, whereas in Telangana it is about INR 10.4 lakhs. Although the cost disadvantage of the BEV compared with the gasoline and diesel models is much less in both states than when compared with the CNG model, it still ranges between INR 4.5 and INR 5.5 lakhs. In both states, the costs of taxes and fees, insurance, fueling, and maintenance are lower for the BEV compared to all conventional vehicles, but the BEV has disproportionately higher vehicle procurement and opportunity costs. Thus the purchase incentive of INR 10,000 per kWh battery

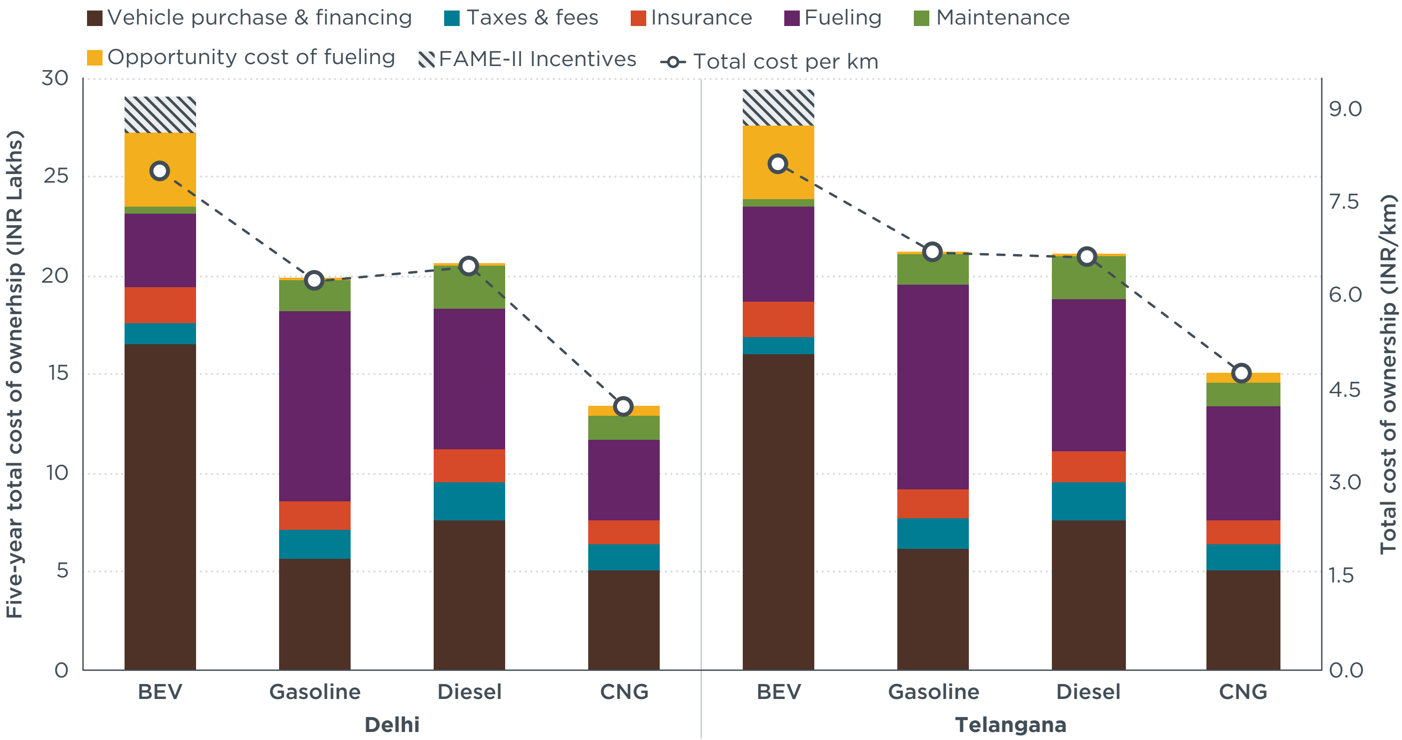

Figure 1. Five-year TCO of BEV versus conventional vehicles on ride-hailing platforms in baseline scenario.

capacity available under FAME-II does not go far enough in competitively positioning the BEV. This indicates that additional incentives are warranted in the near term.

Financial incentives under proposed and hypothetical policy (new policy scenario)

KEY ASSUMPTIONS

Here we introduce several polices and actions—some already proposed and some hypothetical—that would enhance the cost-competitiveness of electric ride-hailing and we analyze their cumulative effect on the TCO. The following adaptations are analyzed as opportunities to bridge the price differential and strengthen the case for BEVs in Indian ride-hailing fleets.

- **DC fast charging deployment.** As previously mentioned, charging duration is a function of both the vehicle's battery capacity and the speed of the charging station. Furthermore, it can be subject to substantial seasonal fluctuations. Our baseline assumption for India indicates that the weighted average time to attain full charge is more than 100 minutes when factoring in seasonal variations. This assumption is much higher than in other regions, such as the United States and the European Union, which deploy high-speed charging infrastructure. Government subsidies for high-speed charging infrastructure for ride-hailing platforms can greatly aid in lowering the opportunity costs to drivers of BEVs on such platforms. India's existing standard for DC charging, Bharat-001, is for 15 kW supply. As an illustration, we model the impacts of all of the previously mentioned incentive mechanisms that are currently in effect under a scenario with availability of 50 kW of DC fast-charging infrastructure, in line with technology deployment in more developed ZEV markets globally. For the BEV assumed in our study, our estimates indicate that 50 kW chargers reduce the weighted average time to attain full charge to around 30 minutes.
- **TCS waiver.** Vehicles with a base price of more than INR 10 lakhs are currently subject to a TCS of 1% of base price. BEVs are not exempt from TCS. We model the impact of a TCS waiver on BEVs.
- **Insurance premium discounts.** The IRDAI has announced the tariff schedules for premium rates for third-party insurance coverage for 2019–2020. Privately owned electric cars have been given a 15% discount on the premium rates charged for privately owned conventional cars. However, such an incentive is not specified for EVs used as commercial cabs. We model the impact of a 15% discount in

third-party insurance premiums for electric cabs in comparison to conventionally powered cabs.

- **Upfront purchase incentives from states.** Delhi's Air Ambience Fund, which is funded primarily through surcharges on the sale of diesel fuel and large diesel vehicles, provides for an upfront purchase incentive of INR 150,000 on all electric cars (Delhi Pollution Control Committee, 2019). However, as per the proposed Delhi Electric Vehicle Policy, this subsidy will cease to exist once the draft policy is finalized and becomes effective (Transport Department, Government of Delhi, 2018). Although the draft policy provides upfront incentives for two-wheelers that are near FAME-II levels, it does not specify any purchase incentives for four-wheeler cabs. Instead, for such vehicles, the draft policy proposes incentives in the form of state and local fee waivers. We model the impact of states providing an upfront purchase incentive at a level matching the subsidies provided under FAME-II at INR 10,000 per kWh. For the BEV in this study, that equates to INR 185,550.
- **Fee waivers from state and local governments.** Key state and local fees applicable to vehicles operating on ride-hailing platforms include registration fees, permit fees, annual or quarterly road taxes, and annual parking charges**.** The proposed Delhi Electric Vehicle Policy exempts BEVs from all of these state taxes and fees (Transport Department, Government of Delhi, 2018). The proposed Telangana Electric Vehicle Policy exempts BEVs from the road tax (Transport Department, Government of Telangana, 2017). We model the cost advantage presented to BEVs through such fee waivers.
- **Rebates on trips taken on electric cabs.** Delhi's proposed Electric Vehicle Policy suggests a rebate of INR 10 per trip to passengers for rides on EVs through ride-sourcing platforms, with the objective of making such rides 10% to 20% cheaper than rides on conventionally powered cabs. Although this is a commendable initiative to make rides on electric cabs more attractive to passengers, it does not compensate the cab driver. We model the impact of states providing a rebate of INR 10 per trip, as proposed in Delhi's draft policy, but with passengers and cab drivers each receiving 50% of the rebate amount.
- **Bulk purchase discounts from aggregators.** We also consider the possibility of BEV drivers receiving an upfront discount on the purchase of the BEV through bulk deals negotiated between the aggregator and the manufacturer. Such a practice was adopted by Ola, for example, through incentives up to INR 1 lakh, including a purchase discount of INR 60,000; this was for drivers who adopted CNG vehicles on the Ola platform following the Supreme Court's directive in Delhi for commercial vehicles to transition to CNG as an air pollution control measure (Daniels, 2015). We model the impact of the same level of purchase incentive that was offered for CNG vehicles earlier, specifically INR 60,000, being made available for those who purchase BEVs.
- **Opportunity cost rebate from aggregators.** We model a rebate made available to drivers at the time of charging at a rate of INR 50 per hour, which is close to 50% of the opportunity cost to BEV cab drivers. Ola Mobility Institute's pilot study in Nagpur also indicates that drivers were compensated for opportunity costs as an incentive to adopt BEVs on their platform (Ola, 2019).

RESULTS

We estimate the incremental cost reduction potential of the proposed and hypothetical incentives and actions described above over the course of a 5-year TCO. In Figure 2, we first illustrate the per-km operating costs of a BEV relative to a CNG and a gasoline vehicle in Delhi and a diesel vehicle in Telangana, shown in the brown bar on the left.[3] The cost differential for the BEV is INR 3.72 per km relative to the CNG vehicle, INR 1.73 per km relative to the gasoline vehicle, and INR 1.3 per km relative the diesel vehicle. Subsequently, we illustrate the incremental effect of each policy measure on the TCO of the BEV, estimating their net impact on the relative costs, shown in the blue bars. The red bars indicate the remaining gaps to be covered and the green bars indicate net improvements in the relative TCO of the BEV to the conventional model after factoring in all incentives.

Several of these actions and incentives can bridge much of the gap between the TCO for the BEV and conventional models, particularly the gasoline and diesel models. The largest reduction in TCO comes from deployment of 50 kW fast charging, which substantially lowers opportunity costs for BEV drivers. For example, access to 50 kW fast chargers can lower the TCO gap of a BEV by 29% over CNG vehicles, and by 62% and 82% over gasoline and diesel models, respectively.

Because the upfront costs associated with vehicle procurement comprise more than half of the BEV's TCO, purchase incentives and discounts from states and aggregators can have a substantial impact on improving

3 As per a Supreme Court order in 2016, new registrations for diesel taxis were banned in the National Capital Region.

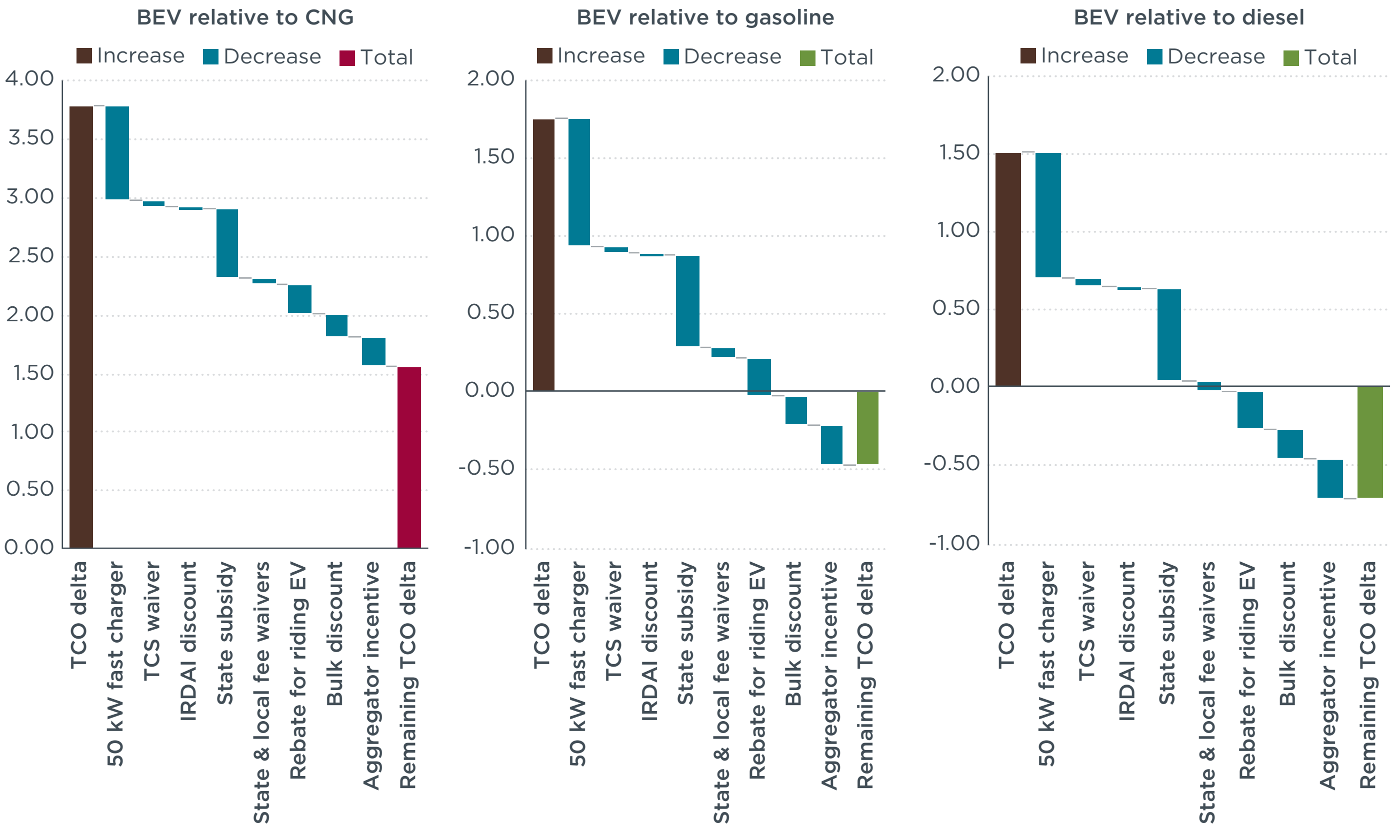

Figure 2. Impact of potential incentive mechanisms and policy actions in bridging the TCO differential between BEVs and conventional vehicles.

their cost competitiveness. For example, under the existing scenario of fast-charger technology deployment, an upfront subsidy from the state to match the incentive provided under the FAME-II scheme—that is, a battery-capacity-linked purchase subsidy at a level of INR 10,000 per kWh—can bridge TCO gaps by about 16% with CNG vehicles, by 34% with gasoline vehicles, and by about 45% with diesel vehicles. Aggregators can pass on the benefits of bulk procurement deals to drivers on their platforms who adopt BEVs. A bulk purchase discount level of INR 60,000 per vehicle can bridge the gap further by about 5% with CNG vehicles, and by 11% and 15% with gasoline and diesel vehicles, respectively. Although waivers in state and local taxes and fees are important components in signaling ecosystem shifts toward electrification, in terms of financial impact on consumers of high-utilization vehicles, upfront subsidies are much more effective. Coupled with some immediate opportunities to offer concessions for commercial electric vehicles on third-party insurance premiums set by the IRDAI and the TCS levied on vehicles costing more than INR 10 lakh, the incentives discussed above can bridge up to 48% of the TCO gap between electric and CNG models, and more than 100% of the gap with gasoline and diesel models.

To further improve the competitiveness of BEVs compared to CNG models, additional incentives are required. Such incentives could be in the form of trip-based rebates to cab drivers. Delhi's proposed Electric Vehicle Policy, for example, suggests a rebate of INR 10 per trip to passengers on app-based cab rides on electric vehicles. We have already considered a scenario wherein 50% of this rebate is transferred to the passenger, while 50% of the rebate is transferred to the cab driver. This is a powerful incentive mechanism that can equal the contribution of incentives such as the recent reduction in the GST rate for electric vehicles from 12% to 5%. Note, too, that such incentives can also be paid by passengers. For example, following the zero-emission mandates on for-hire vehicles in London (Transport for London, n.d.; Uber, 2019), Uber has added a 15 pence per mile charge as a clean-air fee on all passengers taking rides through its platform in London to help fund drivers transition to electric vehicles (Uber, 2019). Uber aims to raise 200 million pounds through this initiative by 2025, having already raised 30 million pounds since the launch of the fee in January 2019 (Prynn, 2019).

Opportunity costs are the second largest cost to BEV drivers after procurement costs. Compensating drivers for time spent charging can help address such losses. For example, the electric cab pilot project conducted by Ola

Mobility Institute provided monetary compensation to drivers for time spent charging. At the existing level of fast-charging technology deployment in India, our estimates indicate that BEV drivers incur opportunity costs of approximately INR 1.5 per km, which is equivalent to about INR 112 per hour. This is considering that it takes an average of 101 minutes to charge a BEV, a time that takes into account seasonal variations on the rate of DC fast charging. It is important to note that government-, utility-, and aggregator-led investments in deployment of next-generation DC fast chargers in India can significantly lower the opportunity costs to BEV drivers and this is the long-term, sustainable solution. For example, deployment of 50 kW fast chargers reduces the opportunity costs from INR 1.2 per km to INR 0.3 per km. Opportunity cost rebates provided by aggregators of 50% of the current costs, for example INR 50 per hour of time spent charging, can help drivers transition toward electric vehicles until investments in high-speed chargers are made.

Policy implications

Based on the results of our TCO analysis, this section summarizes our observations regarding areas of policy focus. These encompass key actions from the government, app-based aggregators, and manufacturers that can improve the economics for drivers and aid in the transition to electric vehicles in ride-hailing platforms in India.

Investments in high-speed DC fast-charging infrastructure are critical in India. The limited charging infrastructure in India is low speed. The charging infrastructure guidelines issued by the Ministry of Power in India recommend that all public charging stations be equipped with any one or combination of CCS and CHAdeMO chargers of minimum 50 kW, Type-2 AC chargers of minimum 22 kW, or Bharat DC-001 chargers of 15 kW (Government of India, 2019). Our analysis indicates that access to 50 kW chargers can save drivers close to 100 minutes a day on charging time compared to charging through low-speed chargers. Such a scenario dramatically lowers the opportunity costs faced by drivers, and these costs are the second largest cost after vehicle procurement costs in the TCO. For example, access to 50 kW fast chargers can lower the TCO gap between a BEV and a CNG vehicle by 29%, and by 62% and 82% compared to gasoline and diesel models, respectively. Cab aggregators would greatly improve the affordability and practicality of electric ride-hailing for their drivers by investing in their own network of high-speed charging infrastructure. Opportunity costs would also come down significantly with the introduction of longer-range EV models in India.

Additional support through upfront purchase incentives is key in the near term. Electric cars in India are almost three times as expensive as their conventional base models. The high upfront prices are largely attributable to the cost of batteries, even though global battery costs are expected to significantly decrease from around US$147 per kilowatt-hour in 2020 to US$104 by 2025 (Lutsey & Nicholas, 2019). However, until economies of scale develop in battery production, additional purchase incentives are warranted to cover the incremental cost of technology adoption in India. Our analysis indicates that states can play a key role by providing additional subsidies to complement the incentives available under FAME-II. The FAME-II scheme also specifically solicits state-level action to supplement its incentives through additional financial and nonfinancial incentives (Department of Heavy Industries, 2019). For example, if states match the purchase incentive of INR 10,000 per kWh available under FAME-II in 2020, the TCO differential between electric and CNG models can be bridged by 16%, and it can be bridged by 34% and 45% over gasoline and diesel models. The subsidy of INR 1.5 lakhs available to all electric four-wheelers under Delhi's Air Ambience Fund are a good example of such state-level support. Subsidies for electric ride-hailing vehicles could be cross-financed by levying higher fees or taxes on conventional vehicles.

However, under the draft Delhi Electric Vehicle Policy, the upfront subsidy to cars, including commercial cars, will no longer be available once the draft policy is finalized. Such an action may hinder the economic push required for transitioning ride-hailing fleets to electric. Although Delhi's draft policy proposes additional incentives in the form of waivers in road tax, registration fees, permit fees, and parking charges, the relative contribution of such incentives in comparison to upfront purchase incentives is small. In addition, provided that there is sufficient market force such as a zero-emission vehicle mandate to increase the number of electric vehicles on the road, cab aggregators also could play a role in cushioning upfront costs for drivers by passing on bulk-purchase discounts.

To spur the electrification of ride-hailing fleets in India, drivers will also need per-kilometer financial incentives. An appropriate and feasible way to finance the transition to electric in ride-hailing platforms is to provide incentives to drivers for the clean kilometers traveled. Delhi's proposed Electric Vehicle Policy suggests a rebate of INR 10 per km to be paid to passengers for taking rides on electric cabs on app-based platforms. It is extremely important that drivers get a significant share of such incentives, in addition to improving the attractiveness for passengers of trips taken on BEVs. Following the mandate that for-hire fleets in London transition to electric, Uber is deploying a similar approach to help drivers to upgrade to electric models by levying a fee of 15 pence per mile (about INR 8 per km) to passengers on all rides taken on its platform. All of the money from this fee will be allocated toward a clean air plan that will support drivers in adopting electric models.

There are several other immediate opportunities to strengthen the case for electrification. Some states in India already have proposed waivers of road tax for electric vehicles. The Central Government already has reduced the GST on electric vehicles from 12% to 5% in the national budget for financial year 2019–2020. This is a commendable measure and will have far-reaching impacts on the economics of adopting BEVs for ride-hailing drivers, provided GST rates for conventional vehicles are not lowered as well. Along with the GST rate reduction, the 2019–2020 budget also specifies a write-off of INR 1,500,000 (1.5 lakhs) on annual interest payments toward loans taken for purchasing electric vehicles. The impact of this incentive is not modeled in our analysis, as it relies on making assumptions about annual income levels of drivers. However, it can be broadly stated that such a measure can have significant impacts on taxpayers who are subject to higher rates of income tax. The Central Government also announced that all commercial EVs are to be exempt from permitting requirements and associated fees, and it has proposed a waiver for registration charges on all EVs. In addition to the above measures, other opportunities could promote the electrification of ride-hailing vehicles:

- The relative case for BEVs in ride-hailing fleets could be strengthened with a waiver in TCS. The Central Government levies a 1% TCS on the base price of all vehicles that cost more than INR 1,000,000 (10 lakhs). BEVs currently are not exempt from such a tax. Most four-wheeled BEVs on the Indian market carry a price tag above this threshold, and the majority of the popular conventional vehicles on ride-hailing platforms fall under it.
- The IRDAI has announced a discount in the third party insurance premium rates for electric four-wheelers in the tariff order for financial year 2019–2020. However, this discount of 15%, applies only to privately owned electric cars. An extension of such a discount to commercially operated electric cars could further strengthen the economics for BEVs in ride-hailing fleets.
- Parking fees can be high in large metropolitan areas. For example, Delhi currently levies an annual parking fee up to INR 4,000 for commercial taxis and has been considering increasing this fee five- to six-fold. Exemptions for BEVs in ride-hailing fleets from such charges can be an attractive near-term incentive for drivers to transition to electric models.

Conclusion

Ride-hailing platforms are increasingly catering to India's transportation needs, and the number of cars on them is growing at a rapid rate. Industry estimates indicate that vehicles in taxi fleets and app-based aggregator platforms will account for more than 15% of the passenger vehicle market in 2025. Vehicles in ride-hailing fleets typically travel upwards of 50,000 km in a year, compared to approximately 12,000 km per year for personal vehicles. Electrification of this segment thus presents an opportunity to address emissions and greenhouse gas impacts from high-utilization vehicles and greatly expand consumer exposure to and awareness of EVs. Efforts in this direction are picking up global momentum. Several markets are restricting the operation of conventional vehicles on ride-hailing platforms while preferentially promoting ZEVs through a variety of policy pathways (Rokadiya et al., 2019).

In this paper, we have evaluated the economic impacts of incentives for drivers operating on ride-hailing platforms to switch to electric models. We compared the 5-year TCO of a selected BEV to popular gasoline, diesel, and CNG models operating on ride-hailing platforms in India.

Our analysis found that at current operating costs, existing incentives are insufficient to competitively position BEVs with respect to conventional models in India's ride-hailing fleet. Even after the attractive incentives under FAME-II and a 5% preferential GST rate for electric vehicles, the TCO of the BEV is INR 3.3 (Delhi) and INR 3.7 (Telangana) per km higher than the CNG, INR 1.7 (Delhi) and 1.4 (Telangana) per km higher than gasoline, and INR 1.3 (Delhi, Telangana) per km higher than diesel vehicles. The bulk of the cost difference is due to the higher upfront price of BEVs and the high opportunity costs of fast charging.

However, there are several opportunities to improve the economics of electric models in ride-hailing fleets in India. These include actions and incentives from the Central Government and state governments, cab aggregators, and utilities. Our analysis of such actions and incentives indicates there is the potential to comfortably lower the TCO of a BEV relative to gasoline or diesel models, while improving the TCO by up to 60% over CNG models. Among the various measures described in this study, **deployment of fast-charging infrastructure above 50 kW and introduction of longer-range models are the biggest opportunities to improve the relative economics of BEVs over conventional models in India**. Such measures can enable a faster transition to an electrified ride-hailing fleet in India. It is also important to mention that policy actions such as mandates for ZEVs in ride-hailing fleets can help bring more competition to the market and bring models that offer longer range than the current offerings in India. Both of these can play an important role in improving the overall economics and value proposition of ZEVs in ride-hailing fleets. Further, ICCT studies globally indicate that the economics for BEVs in ride-hailing fleets also improve significantly in the 2025 time frame because of several factors, including declining battery costs, technology advancements in charging infrastructure, and improved penetration of low-cost renewable energy in the electricity mix. In the future, we will also carry out such scenario analyses for ride-hailing fleets in India, to evaluate the shifts in costs beyond 2020.

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